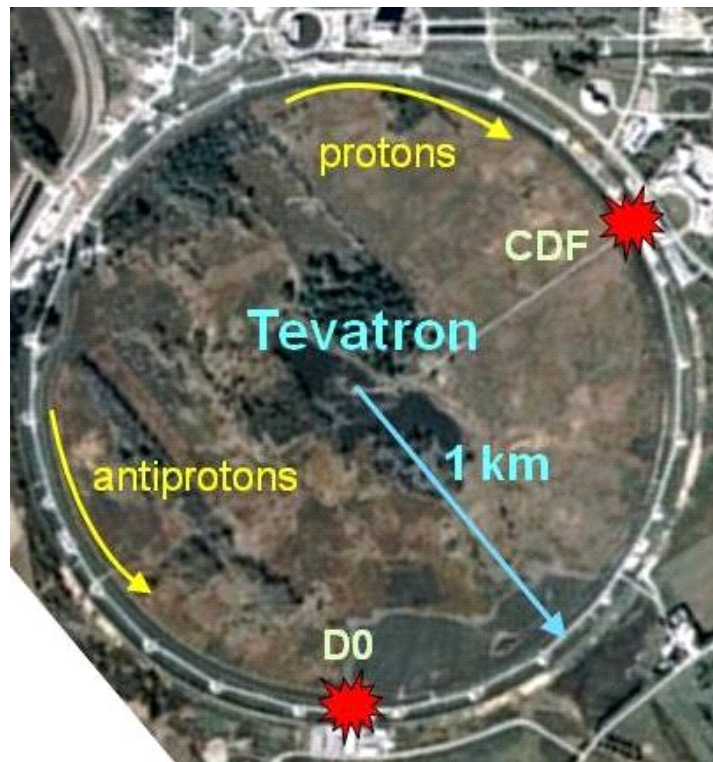




Accelerator Studies at the Tevatron

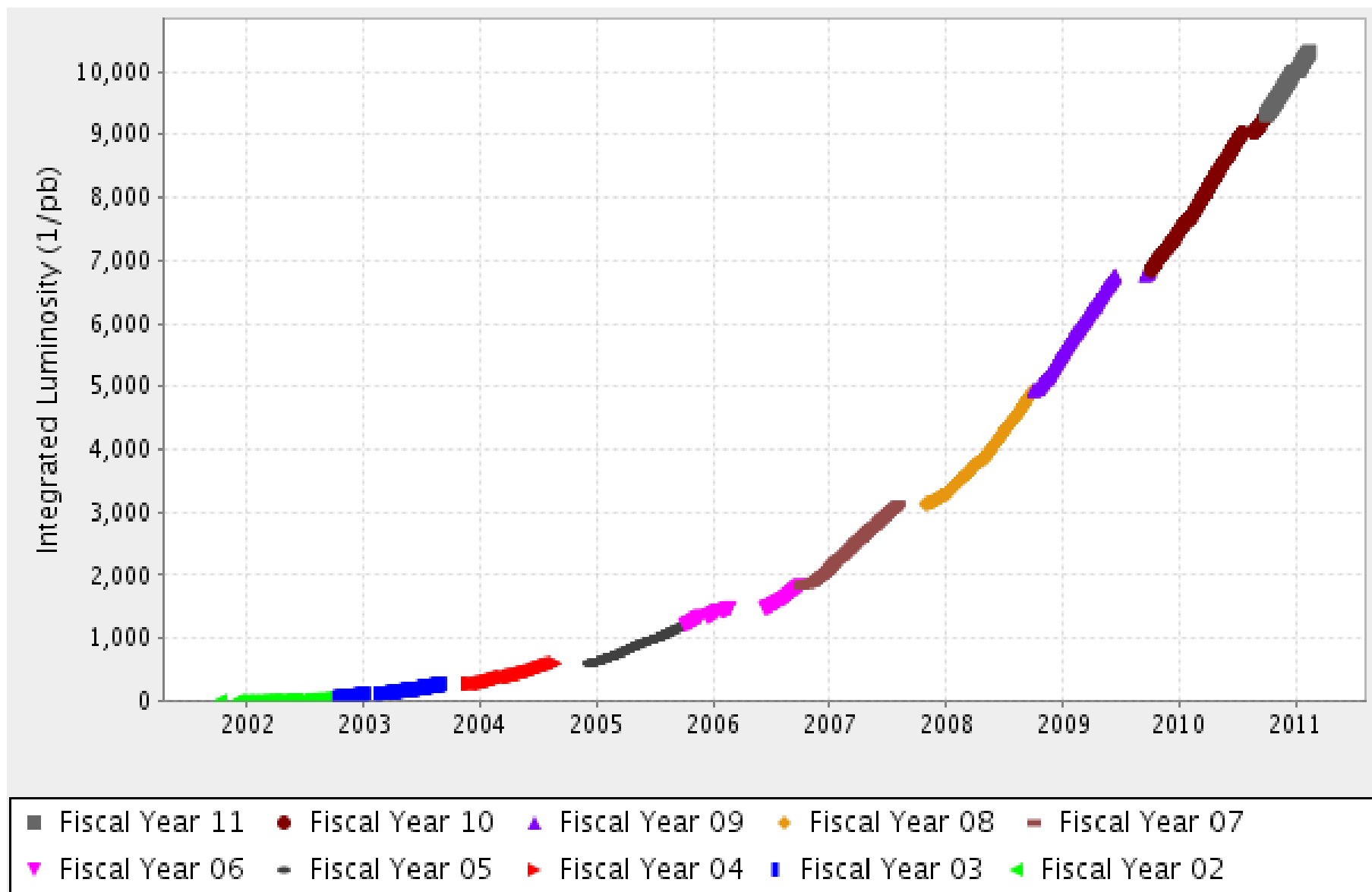


Ron Moore

Fermilab – AD / Tevatron Dept. Head



Tevatron's Day Job = Deliver Luminosity

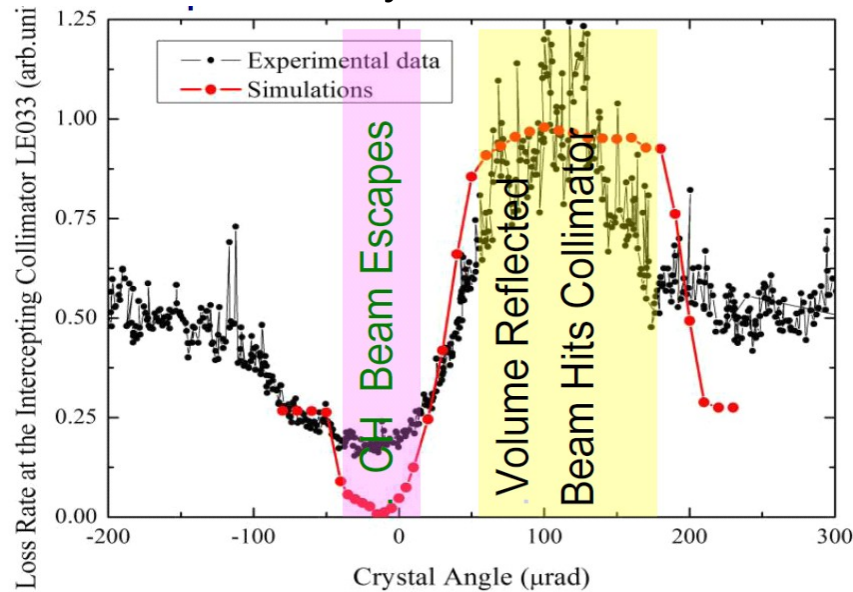




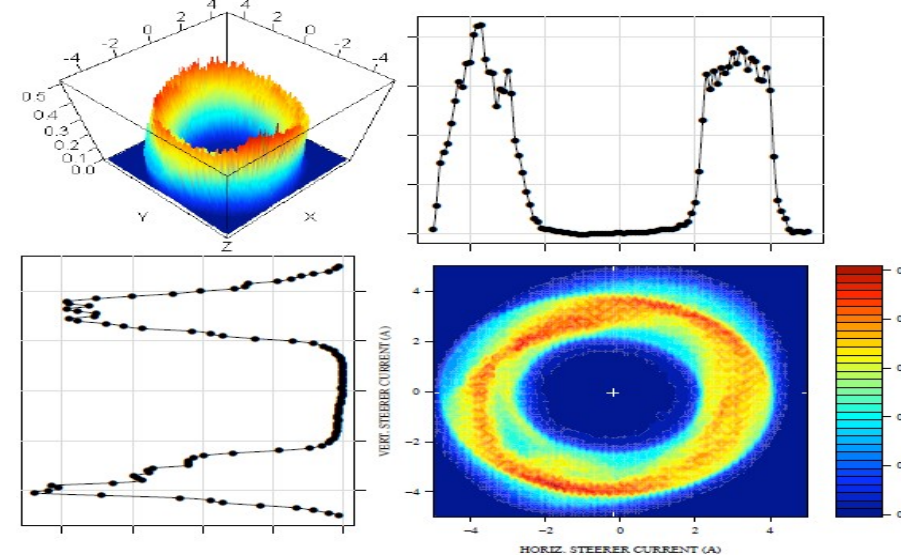
Moonlighting with Accelerator Studies



T980 – Crystal Collimation



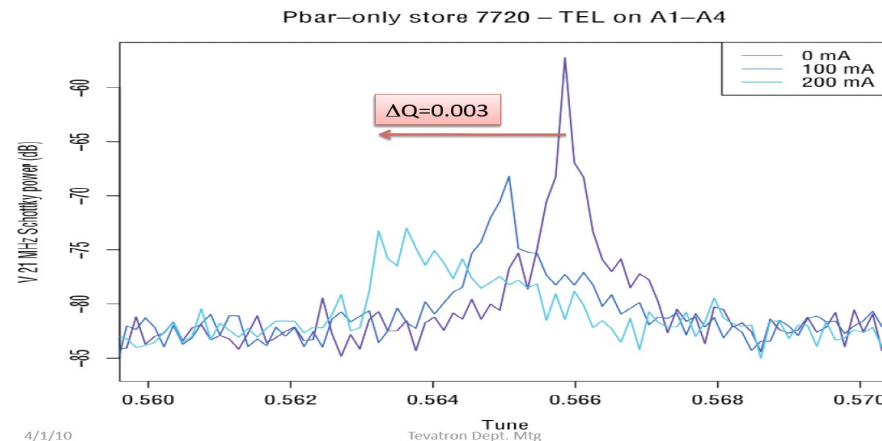
Hollow electron beam collimation



Tune Shift and Spread by Gaussian TEL-2 (antiproton-only study)



Beam-beam compensation with Gaussian electron lens





What else can be done?



- Strong interest from FNAL, CERN/LHC/LARP, BNL to participate in accelerator studies at Tevatron before it is switched off forever
- Both during collider run and a dedicated program after Run 2
 - Exploit “open” time: Oct. 1, 2011 and NOvA shutdown starting Mar. 2012
- Tevatron Accelerator Studies Workshop (*Jan 2010*)
 - <http://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=2921>
 - Generated long list of studies to be considered, rough plans
- Fermilab AAC meeting (*July 2010*)
 - <http://indico.fnal.gov/conferenceDisplay.py?confId=3475>
 - Strong support for an accelerator studies program
- Since Run 2 extension denied, need to move quickly on studies planning



- Use Tevatron essentially “as-is” for collider operation
 - No major changes
 - Adding devices in warm straights possible, but difficult due to time constraints
 - But, it doesn't hurt to ask!
- Consider studies during collider operation, a dedicated run, or both
 - During/End of HEP store like T-980 crystal collimation and hollow e-beam
 - Proton-only or pbar-only studies between HEP stores
 - Desire for pbars during dedicated run (collisions and possibly pbar-only)
- Exploit existing Tevatron instrumentation
 - Need support from CDF & D0 for halo counters, luminosity measurements
- Proponents to supply written note and presentation after study



CERN studies



Topic	motivation	comments	time estimate
Hollow e-beam	LHC collimator upgrades	in progress – mostly parasitic during HEP stores	as requested
Crystal Collimator	LHC collimator upgrades	T-980: in progress – end of HEP stores, some proton-only; plan for dedicated run	>2 shifts EOS, 4 shifts dedicated colliding beams
Luminosity Leveling	upgrades; proof of principle	bunch length changes – relatively easy; dynamic beta* hard here, easier @ LHC?	bunch length – proton-only, end of store, then few stores?
Diffusion & Halo with Beam-Beam	model benchmarking	dedicated proton-only	1 shift
Collimator Impedance	model benchmarking	dedicated proton-only; difficult comparison to LHC?	1 shift
IBS measurements	model benchmarking	dedicated proton-only; overlap with FNAL request	1-2 shifts
Beam-Beam & AC Dipole	measure resonances; proof of principle	dedicated collisions; Ryoichi make visit?	>1 store?
Beam-Beam Emittance Growth	model benchmarking	dedicated collisions; tickle beam(s)	few stores?

listed in order of CERN's priority

Other studies

Topic	motivation	comments	time estimate
Lifetime Measurements (IBS, vacuum, RF noise)	model benchmarking	dedicated proton-only; overlap with CERN request	2 shifts
Coherent Beam-Beam Effect	beam-beam	dedicated colliding beam stores	3-4 shifts
Instability Studies	general; benchmarking	dedicated proton-only and colliding beams	2 shifts
Head-On Beam-Beam Compensation with Electron Lens	beam-beam	colliding beam stores, not necessarily dedicated; some already done; conflict with hollow e-beam	3 shifts
Space Charge Compensation with Electron Column	intensity frontier	dedicated proton-only	4-6 shifts
Electron Cloud	intensity frontier	dedicated proton-only	2 shifts
Phase Averaging	general; beam-beam	dedicated 1x1 colliding beam stores	2 shifts; 2 stores
Lifetime vs Phase Advance btw IPs	general; beam-beam	dedicated (1x1?) colliding beam stores	1-2 shifts
Dynamic Aperture Measurement with AC Dipole	general; operations	dedicated proton-only, possibly between HEP stores	1 shift
Investigate OTR TBT Profile Differences	instrumentation	dedicated proton-only	½ shift
Wide Tune Scans during Collisions	general; beam-beam	2 colliding beam stores, prefer dedicated	2 shifts; 2 stores
Lifetime vs Helix Size	beam-beam	several colliding beam stores, not necessarily dedicated	~few quasi-parasitic stores or 1 dedicated store

some ordering by desire and ease of completion



Eliminated Studies



- Some studies already eliminated due to motivation, complexity/time, ease of completion, required work in tunnel...

crab cavities	large Piwinski angle collisions
collisions with flat bunches (higher order RF cavities)	transverse bunch splitting by beam-beam resonances
$\frac{1}{2}$ integer working point	120/150 GeV stretcher ring tests
crystal channeling with pbars	wire-based beam-beam compensation
cryogenic loss monitors	optical diffraction radiation (ODR) imaging
electron beam profile scanner	hadron-driven plasma wakefield tests



What's Next?



- Estimate 4 weeks for all studies in tables on pages 6-7
 - Padded initial estimates by factor ~ 2 to allow for over-optimism and operational issues, e.g. no beam from injectors, quench recovery
- Requested proponents to refine plans with help from Tevatron experts
 - Specific beam configuration, needed instrumentation, better time estimate
- Consolidate, shuffle priority based on ease to prepare & complete studies
 - Reasonable to reduce scope by eliminating low priority studies
- Studies consistent with normal collider operation can proceed now
 - End-of-store, parasitic during HEP, proton-only between stores
 - T-980, hollow e-beam, lumi leveling via bunch length, some proton-only



What's Next?



- Allowing 1 shift of studies / week or every 2 weeks would be very helpful
 - Only 33 weeks until end FY11 – the hard stop
 - Reduce duration of possible dedicated period
- Scheduling dedicated block of studies (several days?) for
 - doing studies with special configurations, e.g. 1x1 collisions
 - allowing visitors to come and participate in some studies
- 2-4 of weeks of studies until Tevatron termination would be valuable to the accelerator physics community to exploit unique opportunity
 - strong support from other labs and the AAC
 - compare to benefit of 1-2% incremental delivered luminosity over that time
- Need commitment from FNAL management to allocate time

Draft 2010-13 Fermilab Accelerator Experiments' Run Schedule

Typically Revised Annually - This Version from June, 2010

Calendar Year		2010	2011	2012	2013
Tevatron Collider		CDF & DZero	CDF & DZero	OPEN	OPEN
Neutrino Program	B	MiniBooNE	MiniBooNE #		MicroBooNE
		MINOS	MINOS		OPEN
	MI	MINERvA	MINERvA		MINERvA
		ArgoNeuT			
				NOvA	NOvA
SY 120	MT	Test Beam	Test Beam		Test Beam
	MC	OPEN	OPEN		OPEN
	NM4	E-906/SeaQuest	E-906/SeaQuest		E-906/SeaQuest

This draft schedule is meant to show the general outline of the Fermilab accelerator experiments schedule, including unscheduled periods.





Major components of the schedule include shutdowns:

In Calendar 2010, a 4 week shutdown for maintenance scheduled to begin July 19.

In Calendar 2011, no shutdown for maintenance is shown.

A 2012-3 11-month shutdown is shown to upgrade the proton source and change the NuMI beam to the Medium Energy (ME) config.

Duration of the MiniBooNE run will depend on preparations for MicroBooNE.

	RUN/DATA
	STARTUP/COMMISSIONING
	INSTALLATION
	M&D (SHUTDOWN)

15-Jun-10

- Tevatron Collider Run 2 still scheduled to continue through Sept 2011
- Few months “available” for dedicated running before 2012 shutdown
- Impacts of FY11/12 budget shortfall ~~or Run 2 extension?~~



CERN Support (letter from Steve Myers)



We are strongly interested in, or would like to propose, the following experiments and tests with Tevatron beam:

- Tests of hollow e-beam scraping of proton beams for improved LHC collimation.
- Tests of crystal-based halo cleaning for improved LHC collimation.
- Tests of cryogenic beam loss monitors for improvements of present LHC IR's and future IR upgrades.
- Tests of luminosity leveling with dynamic beta squeeze or dynamic crossing angle variation for future LHC performance upgrades.
- Measurements of equilibrium proton beam distribution for improved benchmarking of diffusion and halo models.
- Measurements of transverse resistive impedance from collimators for improved benchmarking of impedance models.
- Measurements of intra-beam scattering (IBS) with various intensities for improved benchmarking of IBS theory and models.
- Measurements of beam-beam resonances using an AC dipole.
- Measurements of beam-beam effects with various harmonic transverse perturbations for improved benchmarking of emittance growth models.
- Measurements of beam-beam effects for different schemes of transverse bunch splitting.
- Collisions with large Piwinski angle, and possibly with longitudinally flat bunches.
- Study of noise effects in collision, in view of future LHC crab cavities.

Proposals for additional experiments and measurements will likely originate from LHC beam experience in 2010. We estimate that the above-mentioned studies require about 25 shifts of 8 hours, which should be distributed over a period of 6-8 weeks.